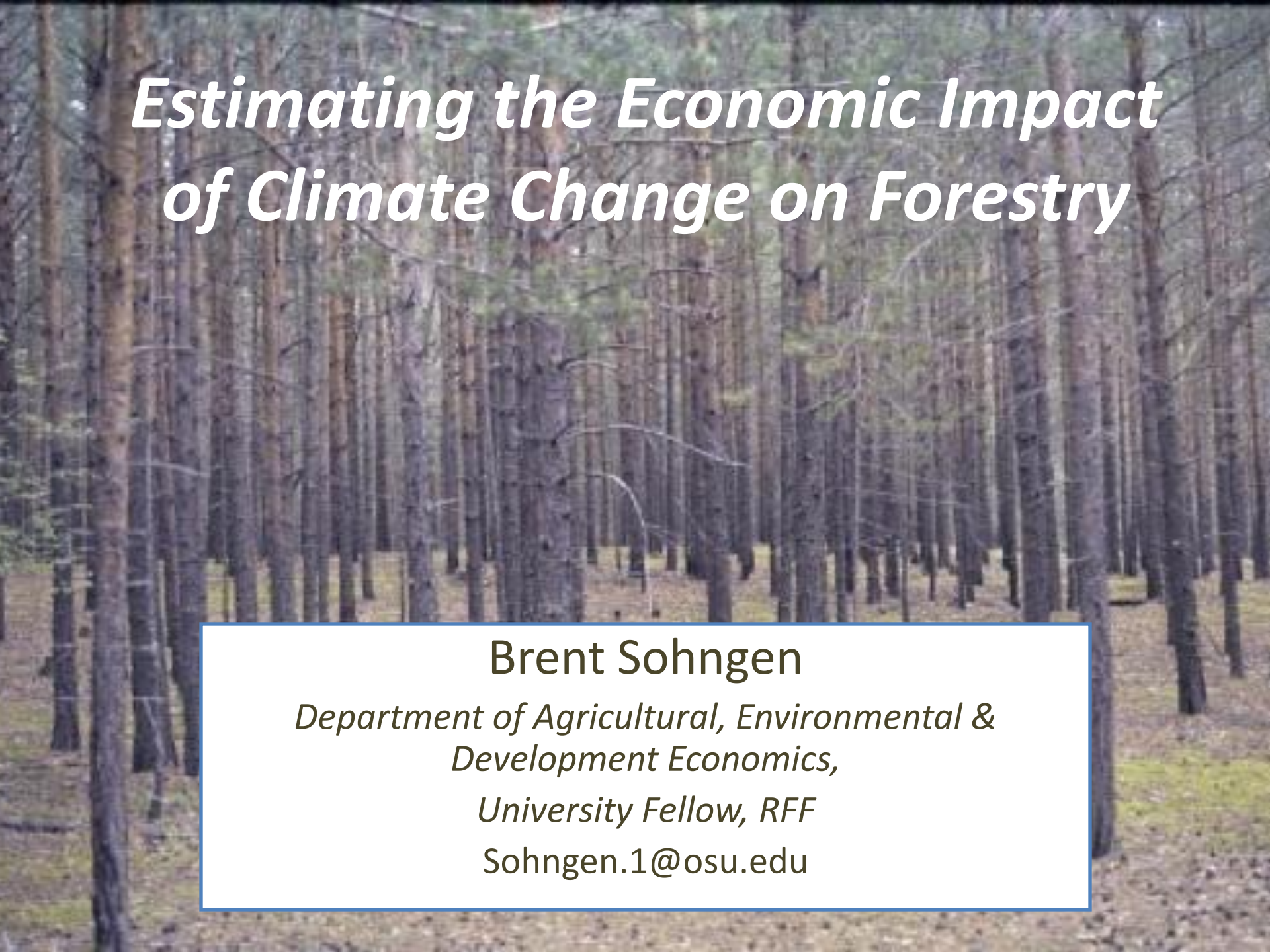

Estimating the Economic Impact of Climate Change on Forestry

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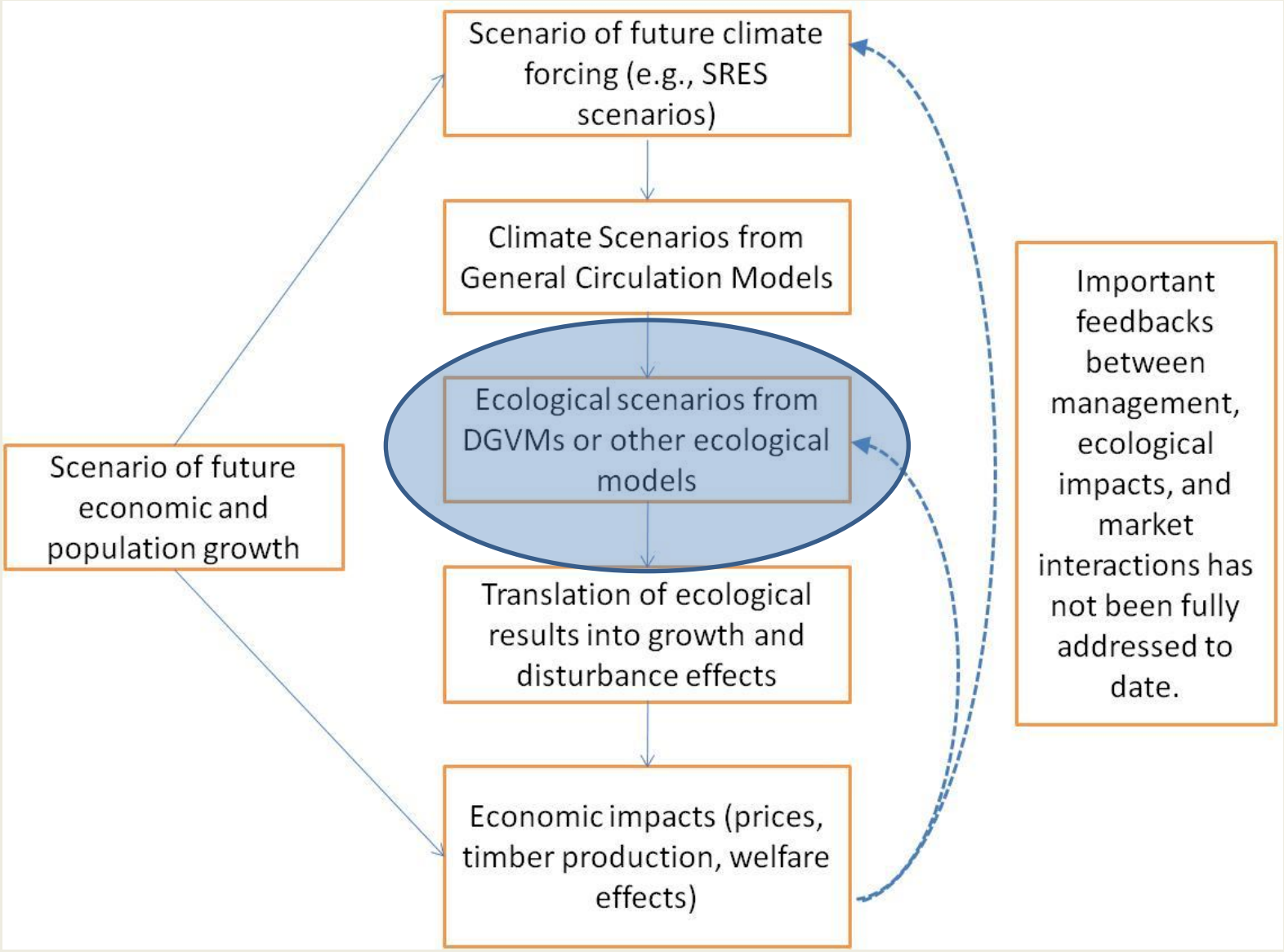
Outline of Presentation

- Methods for assessment
- Ecosystem impacts important for economic analysis
- Some results from a recent assessment.

How are impacts measured?



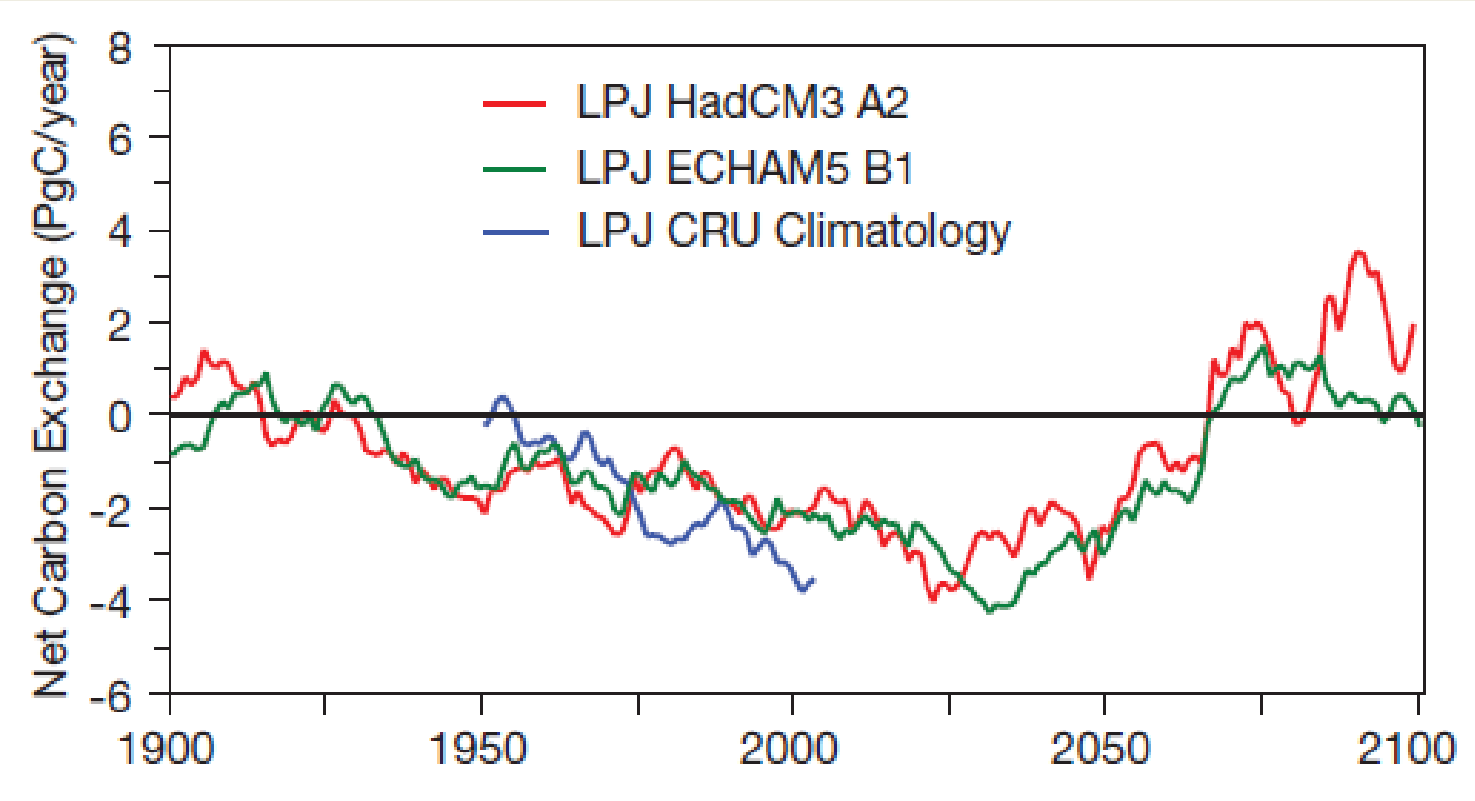
Adaptation of Forests and People to Climate Change. 2009. Alexander Buck, Pia Katila and Risto Seppälä. (eds.). IUFRO World Series Volume 22. Helsinki. 224 p.

Ecosystem Impacts

- Productivity changes (IPCC, 2007)
  - CO_2 fertilization (e.g., Norby et al., 2006).
  - Warming in colder climates.
  - Precipitation gains where water is limited.
- Some current evidence that historical climate change and CO2 change have increased productivity to date (e.g., Myneni et al., 1997; Boisvenue and Running, 2006; McMahon et al., 2010).
- Potential limits to productivity gains: Net impacts
  - Species composition, age structure, seasonal and daily precipitation and temperature patterns, etc.
  - Drying and forest fire effects

Global Ecosystem Impacts

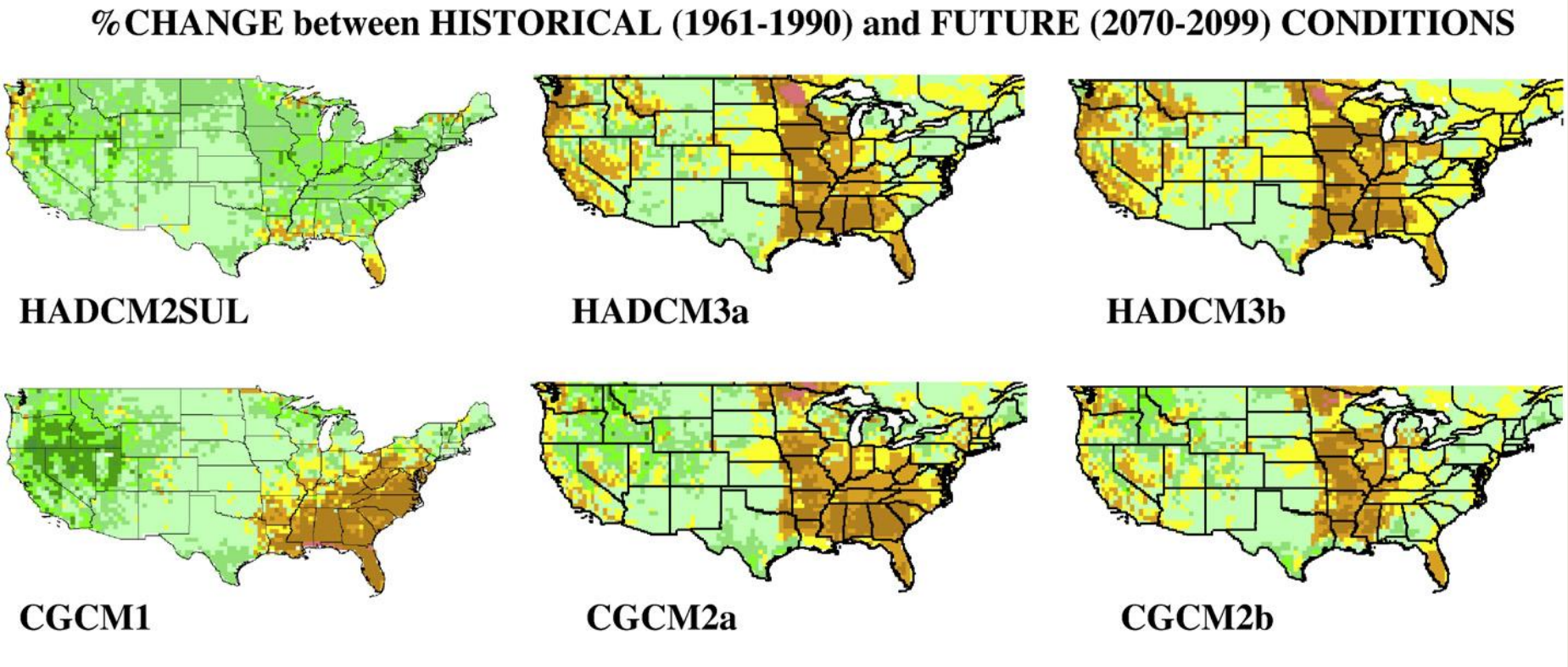
- *Losses ultimately weigh down gains:* Ecosystems turn from carbon sink to source within the next several decades, due to fire and other disturbance



IPCC (2007) WG 2, Chapter 4, Figure 4.2

US Ecosystem Impacts

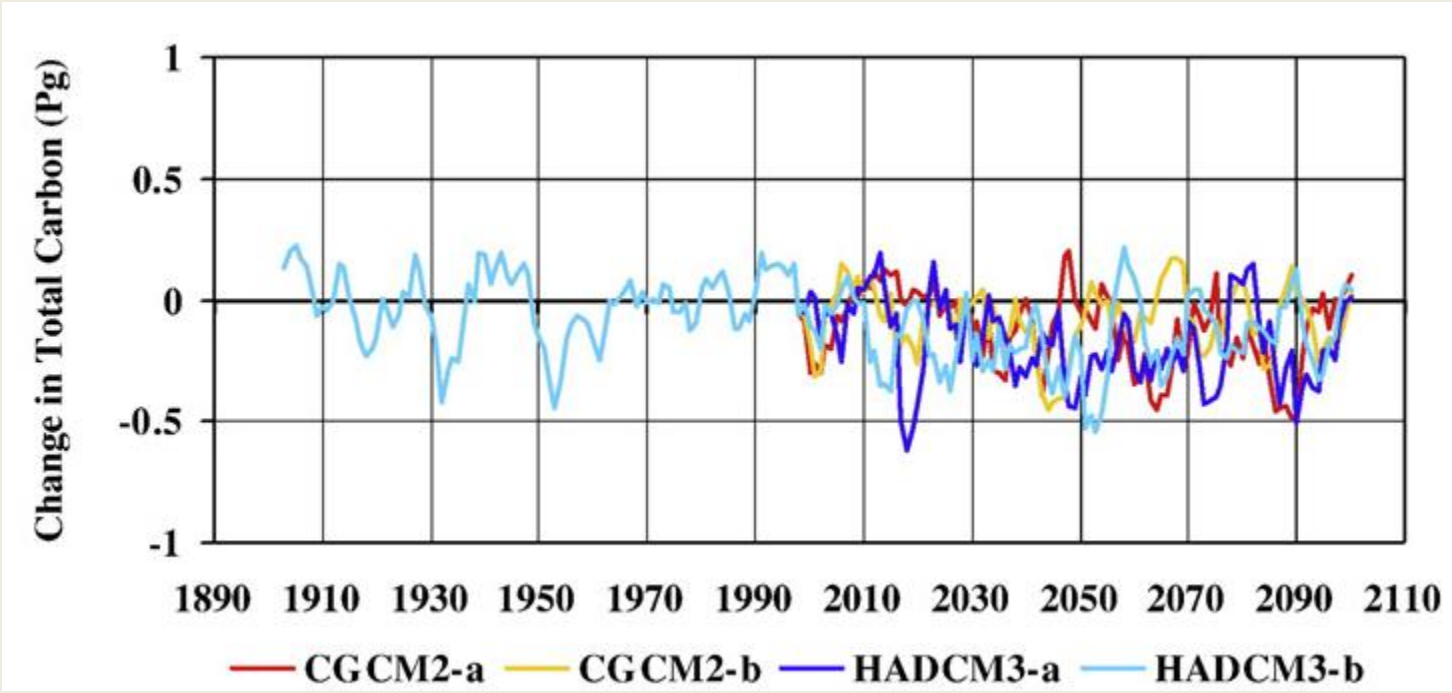
- *Reduction in total ecosystem carbon with climate change*.
  - Losses greatest in eastern US
  - Losses greater with more recent climate scenarios



Bachelet et al. (2008)

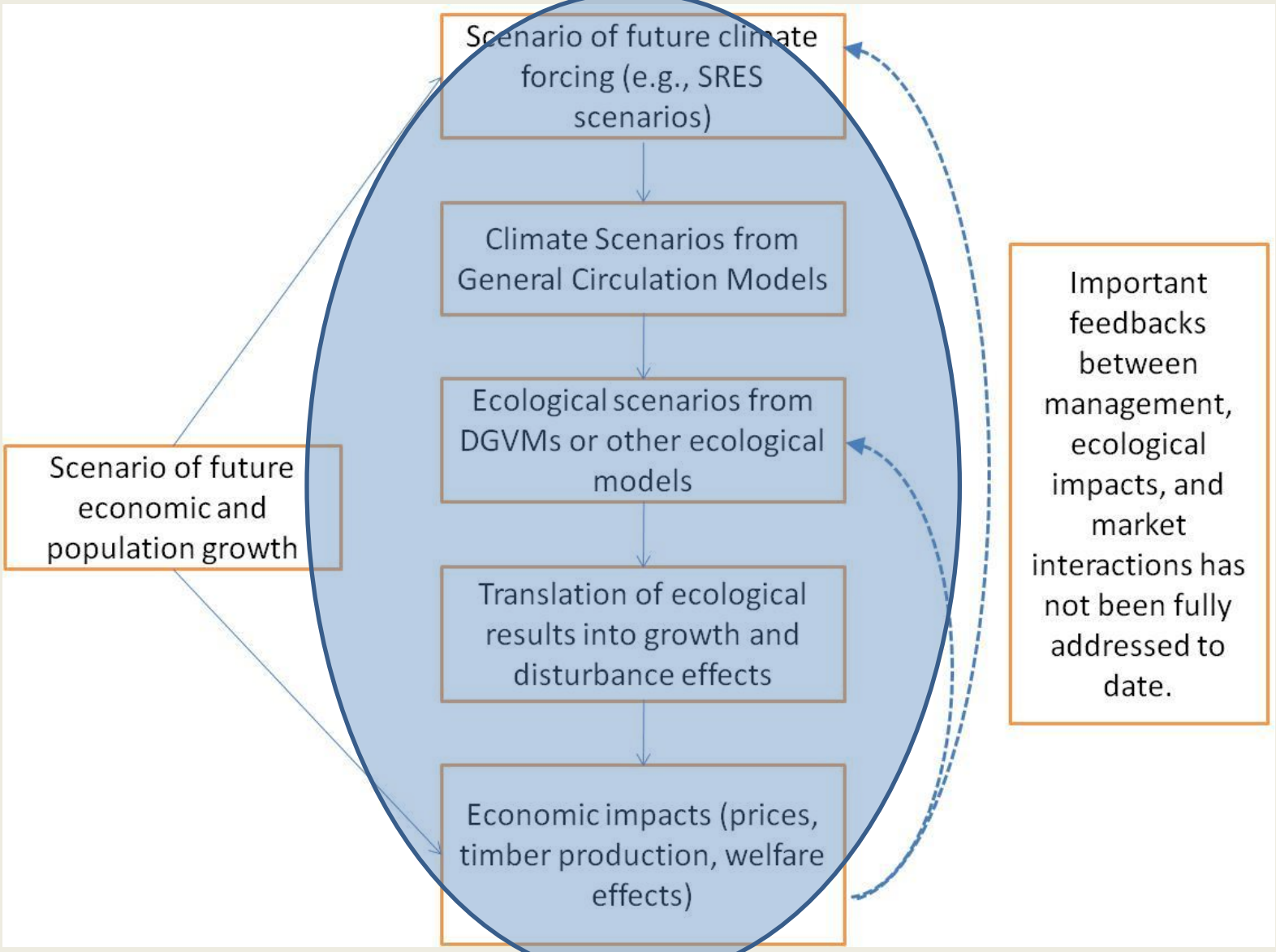
US Ecosystem Impacts

- *How big might the losses be?*
  - *Emissions of up to 500 million t C per year*
  - *Total loss over century of 10-20 billion t C.*



Bachelet et al. (2008)

Need to integrate…



Adaptation of Forests and People to Climate Change. 2009. Alexander Buck, Pia Katila and Risto Seppälä. (eds.). IUFRO World Series Volume 22. Helsinki. 224 p.

Summary: Timber market results to date

Region	Output		Producer Returns
	2000–2050	2050–2100	
North America	**-4%** to +10%	+12 to +16%	Decreases
Europe	**-4%** to +5%	+2 to +13%	Decreases
Russia	+2 to +6%	+7 to +18%	Decreases
South America	+10 to +20%	+20 to +50%	Increases
Aus./New Zealand	**-3** to +12%	**-10** to +30%	Decr. & Incr.
Africa	+5 to +14%	+17 to +31%	Increases
China	+10 to +11%	+26 to +29%	Increases
SE Asia	+4 to +10%	+14 to +30%	Increases

Alig et al. (2002), Irland et al. (2001), Joyce et al. (1995, 2001), Perez-Garcia et al. (1997, 2002), Sohngen et al. (2001), Sohngen and Mendelsohn (1998, 1999), Sohngen and Sedjo (2005); [2] Karjalainen et al. (2003), Nabuurs et al. (2002), Perez-Garcia et al. (2002), Sohngen et al. (2001) ; Lelyakin et al. (1997),

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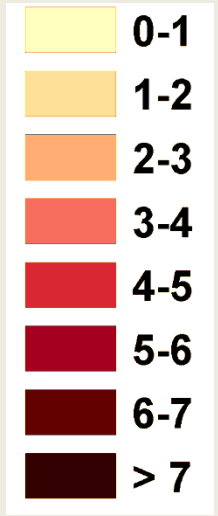
Updated Analysis

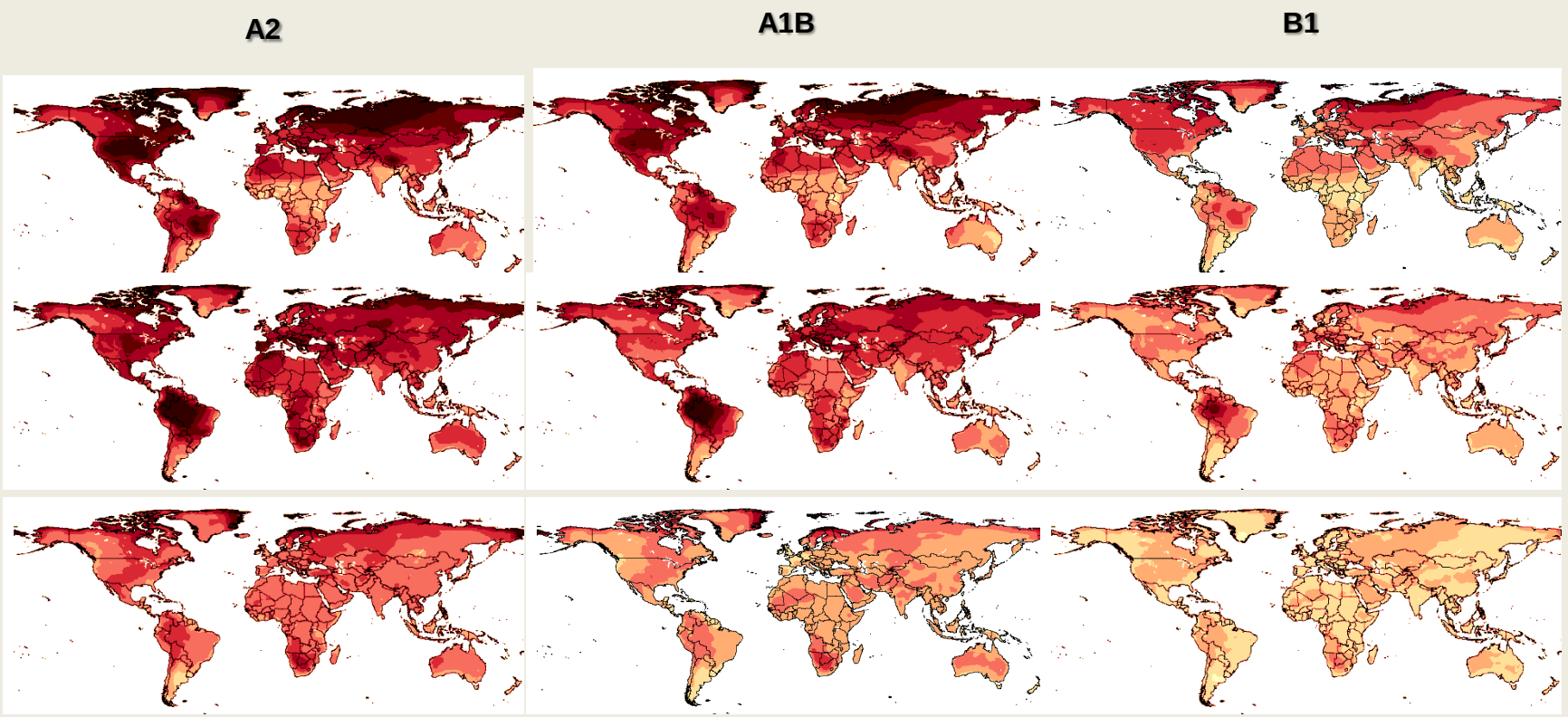
- Climate Change:
  - A2, A1b scenarios
  - CSIRO, Hadley, MIROC models

- Ecological Analysis: DGVM
  - MC1 model (MAPPS and Century Model)

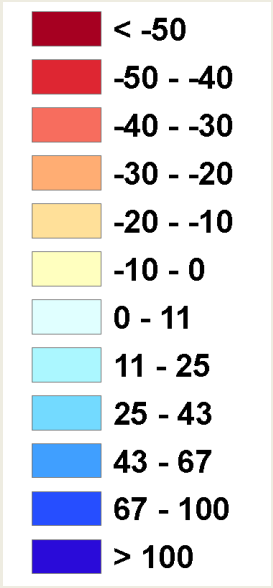
- Economic Analysis:
  - Global Land Use Model (Sohngen and Mendelsohn, 2007)

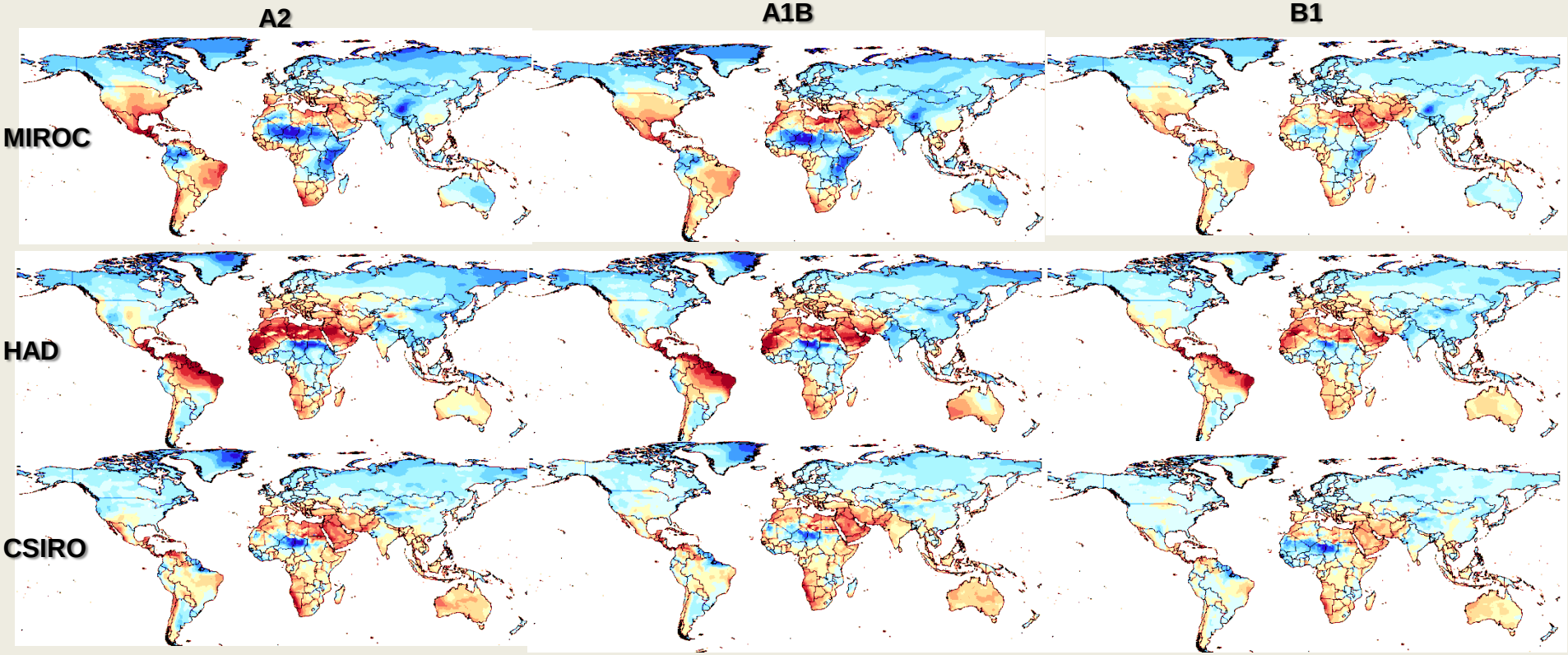
Change in tmax
2070-2099 vs 1961-1990





% Change in precip.
2070-2099 vs 1961-1990





Approach to Economic Analysis

- Ecosystem Model (DGVM) provides information on
  - Shift in range for timber species
  - Natural disturbance losses (% stock burned)
  - Net primary productivity, net ecosystem productivity, and net biological productivity

- Data provided by DGVM
  - 0.5 degree grid cells for globe.
  - Annually to 2100.

Approach to Economic Analysis

Incorporate several factors

- Yield change is proportional to the change in NPP
- Stock losses due to burned area
- Area suitable for trees changes

- Yield changes captured as:

$$V_{A,t} = \sum_{a=1}^{A} \delta_t \dot{V}_{a,t}$$

- Stock losses captured as

$$X_{a+1,t+1} = (1-\gamma_t) X_{a,t} - h_{a,t} + g_{a=1,t}$$

- Use maps of shifts in ecosystem types.

Adaptations Incorporated

- Manage existing stock by
  - changing rotations
  - Salvage
- Replant new species if growing and economic conditions warrant
- Manage future stock by
  - Changing rotations
  - Changing management & investments

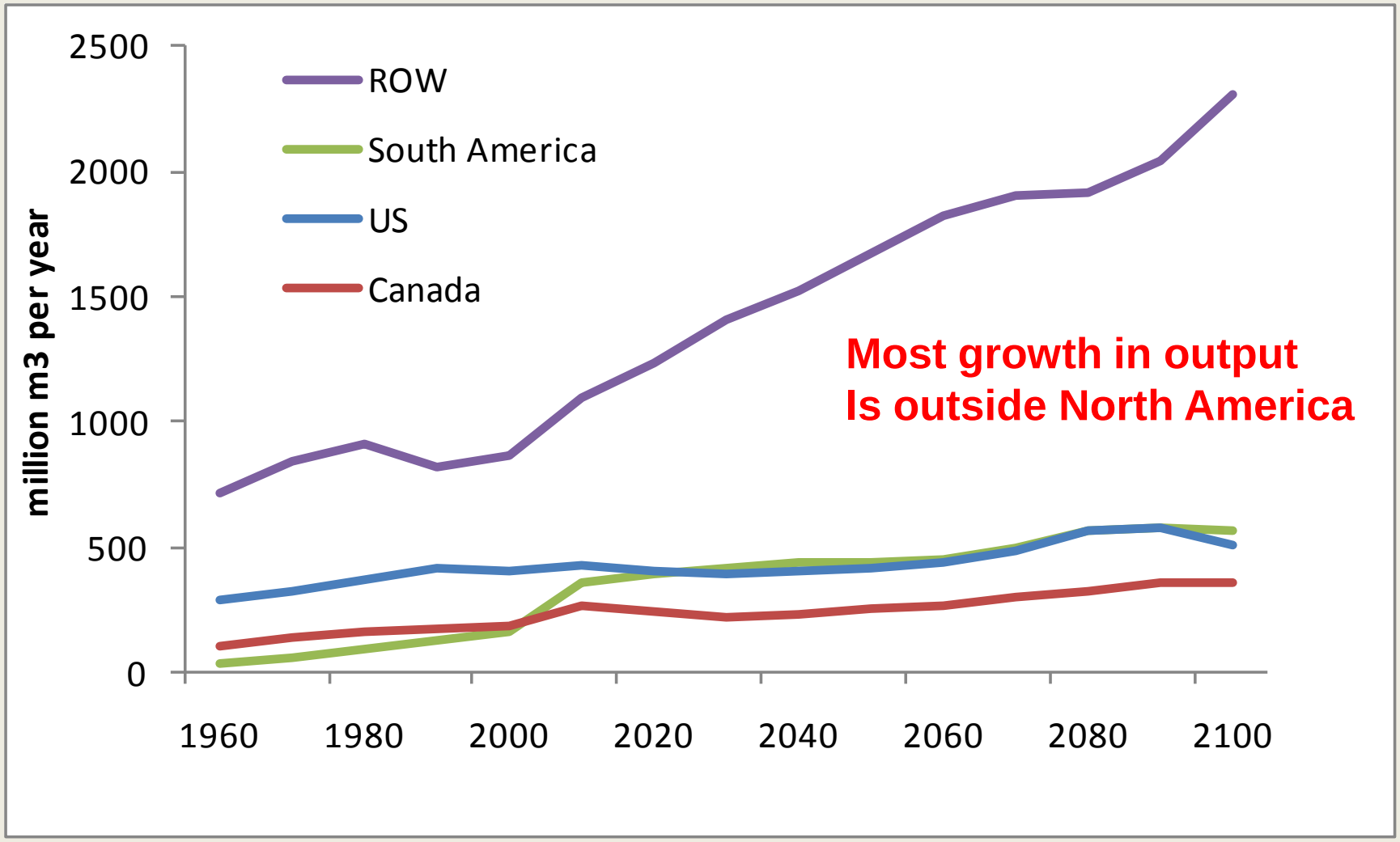
Some Results from Economic Analysis

- Climate Change strengthens current trends towards shorter rotations and production in subtropical regions.
  - South/Central America, Oceania, South Africa

	Age	m3/ha/yr	$/ha
US Southern Pine	30	4.8	$3,180
S. China mixed	50	1.8	$771
Canada Boreal SW	70	1.6	$288
Russia Boreal SW	100	1.0	$58
South Amer. Eucalypt	10	7.0	$8,453
Oceania SW	30	13.5	$7,937

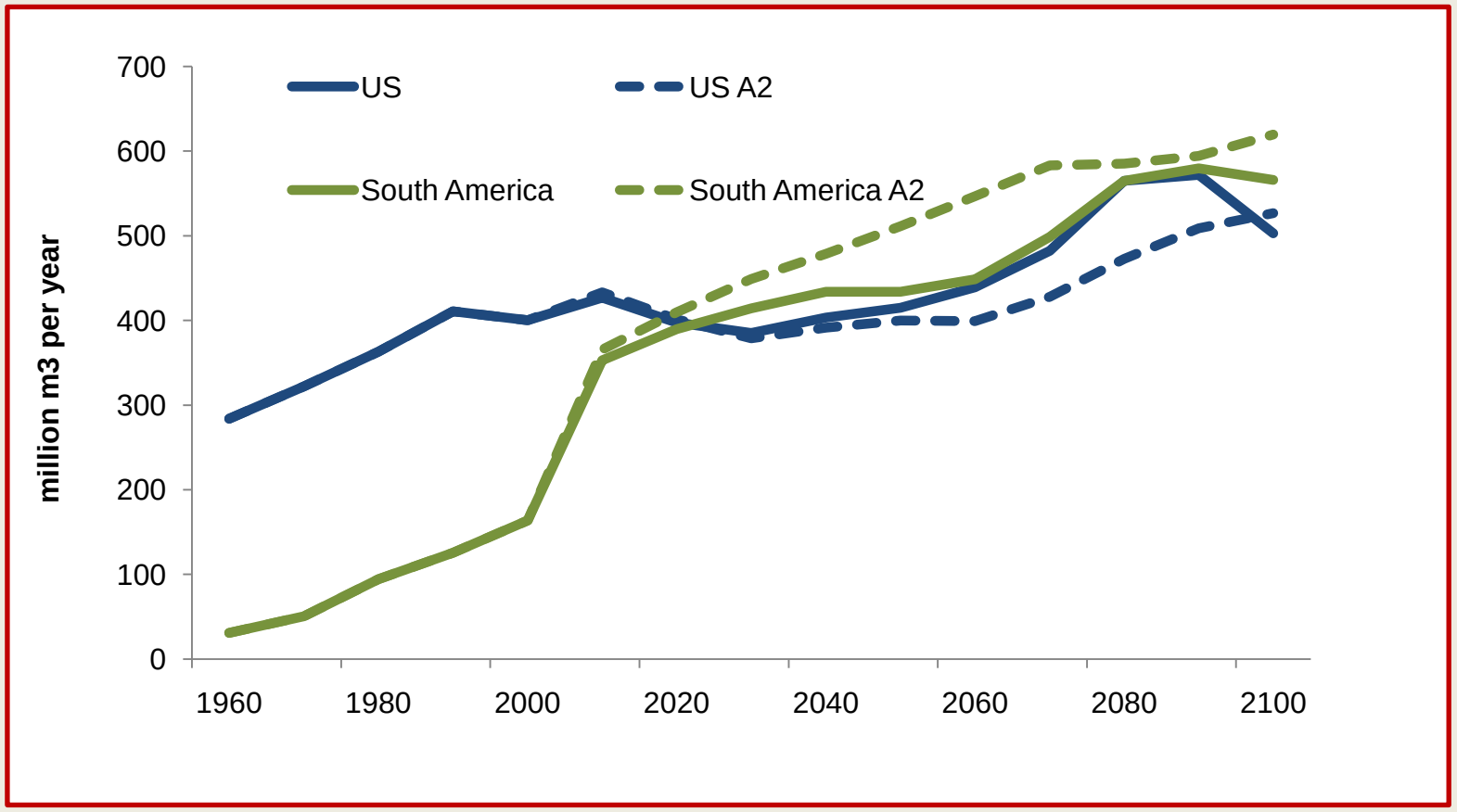
Source: Sohngen, 2010

Market Projections: No Climate Change



Market Projections with Climate Change

- South America gains some advantage under A2 for example

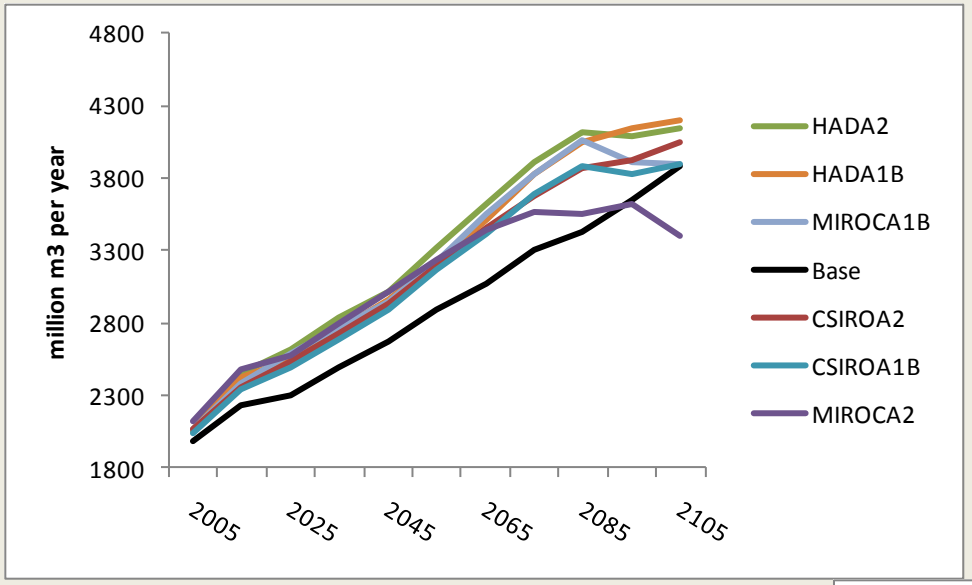


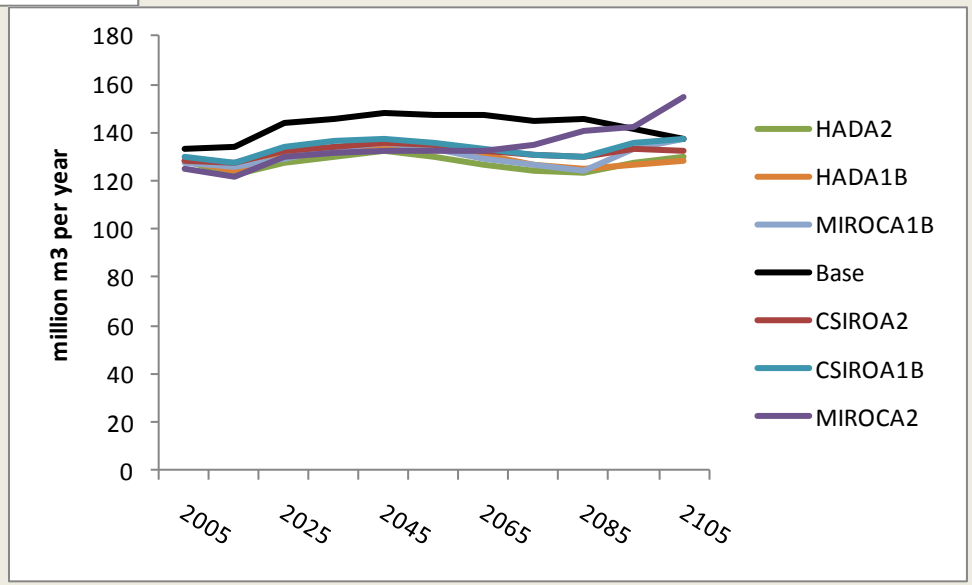
Some Results from Economic Analysis

- Climate Change strengthens current trends towards shorter rotations and production in subtropical regions.
  - South/Central America, Oceania, South Africa

- Global output rising and timber prices falling

Global Output and Prices fall by 5-15%

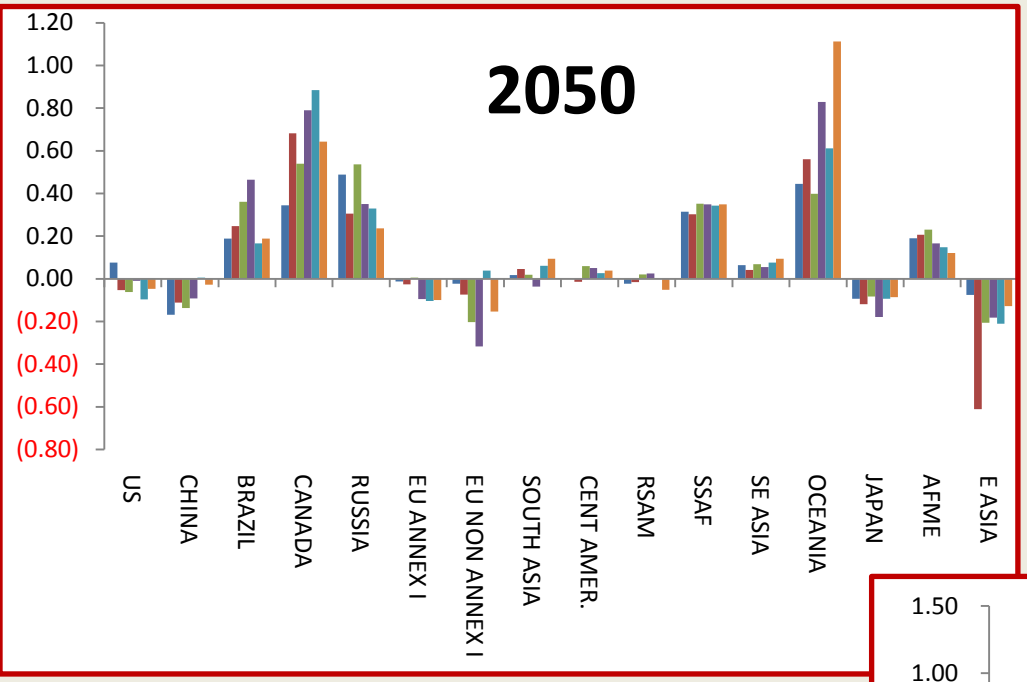


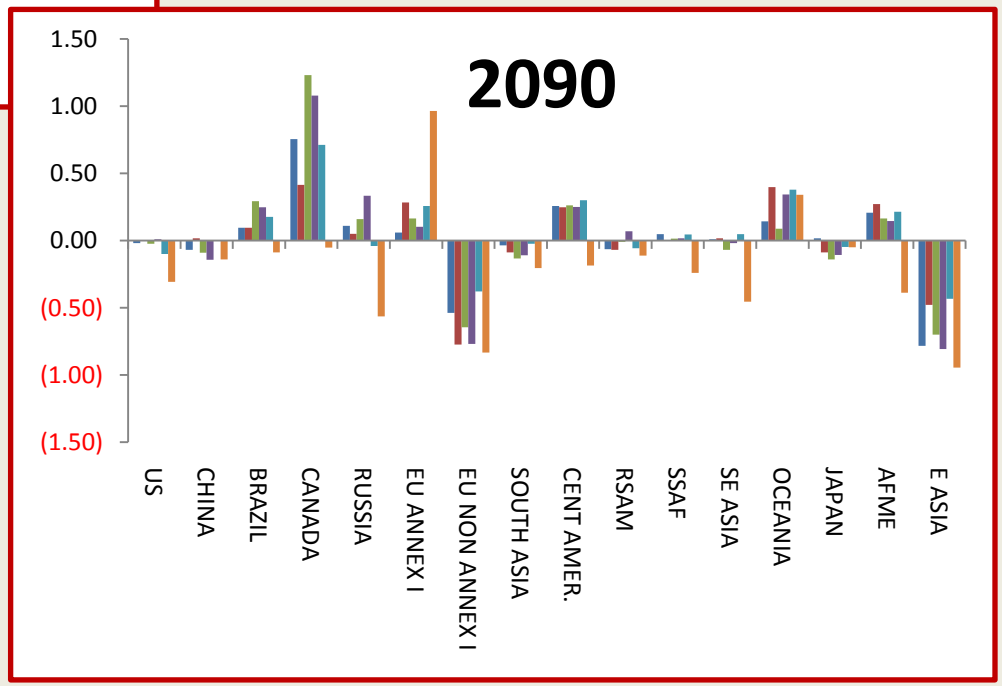


Some Results from Economic Analysis

- Climate Change strengthens current trends towards shorter rotations and production in subtropical regions.
  - South/Central America, Oceania, South Africa
- Global output rising and timber prices falling
- Regional results suggest winners and losers, but dependent on climate scenarios.

Regional results variable



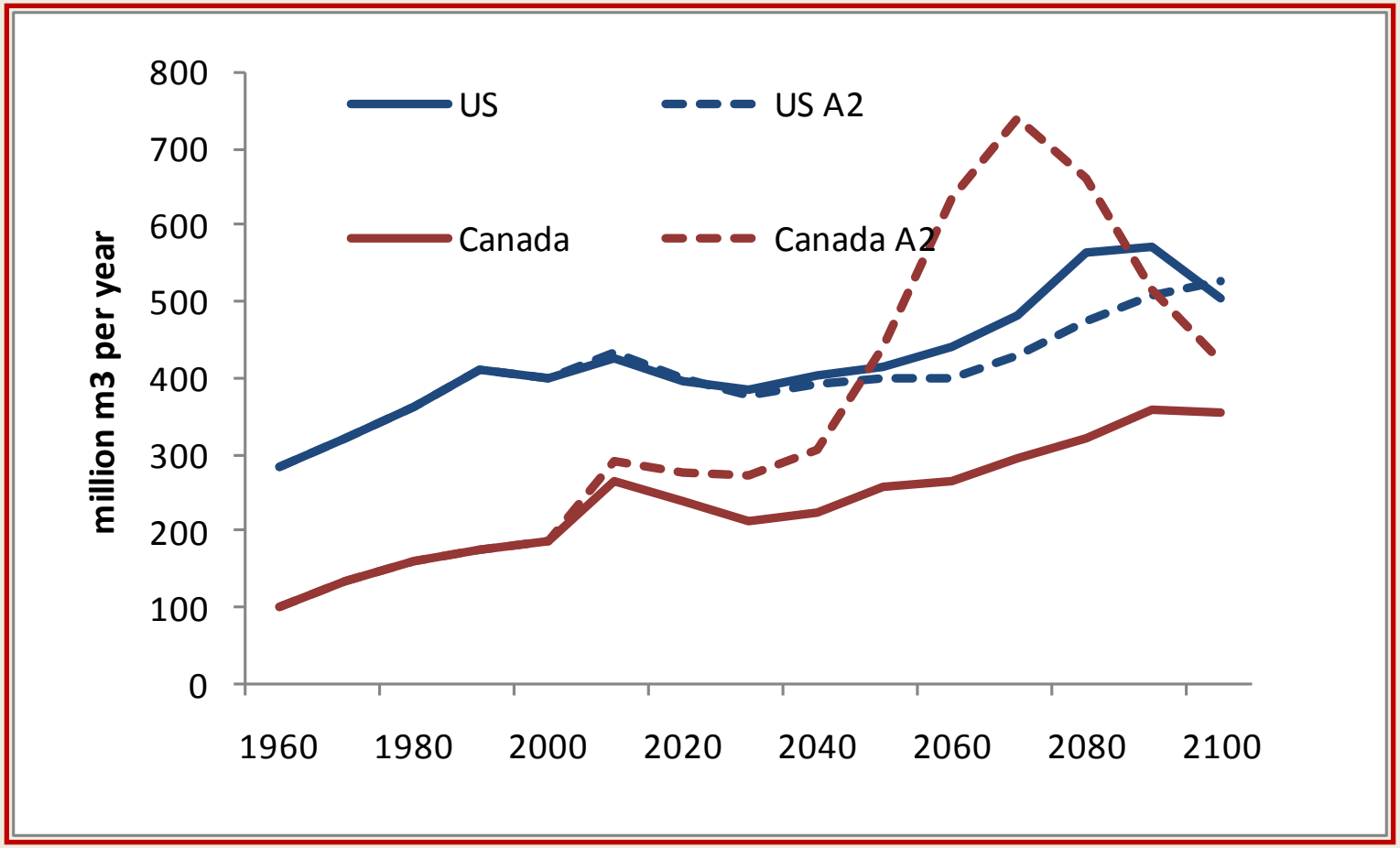


Some Results from Economic Analysis

- Climate Change strengthens current trends towards shorter rotations and production in subtropical regions.
  - South/Central America, Oceania, South Africa
- Global output rising and timber prices falling
- Regional results suggest winners and losers, but dependent on climate scenarios.
- Management of forest stocks complicated by disturbance.
  - Large scale disturbances already influencing outputs in many regions (Mountain pine beetle in Canada, Forest fires in Russia, etc.).
  - Disturbance patterns expected to change with climate change.

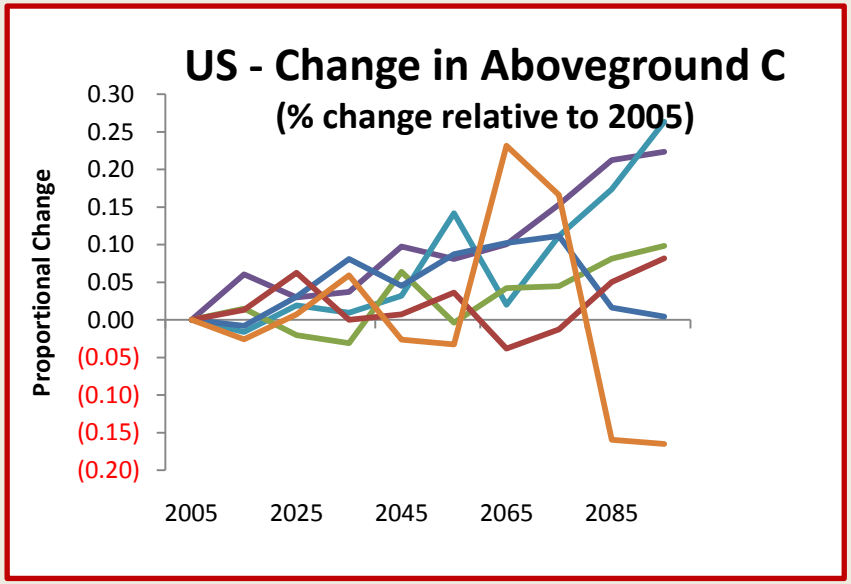
Disturbance and Adaptation.

- US and Canada example…

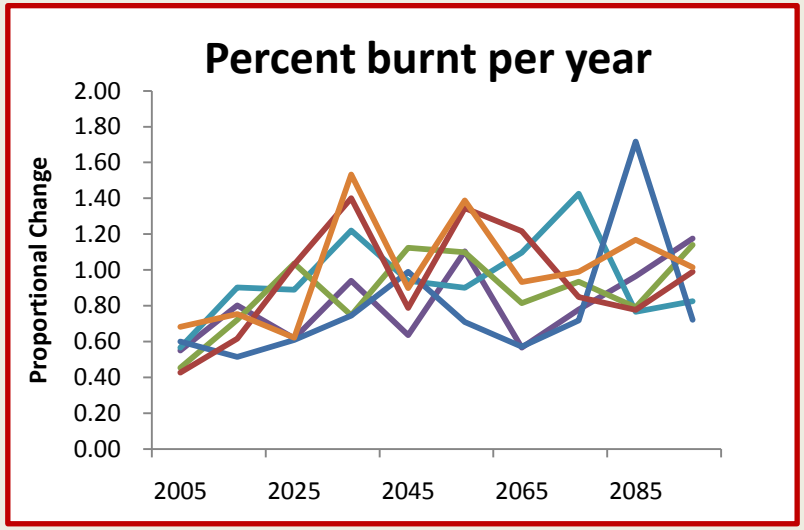


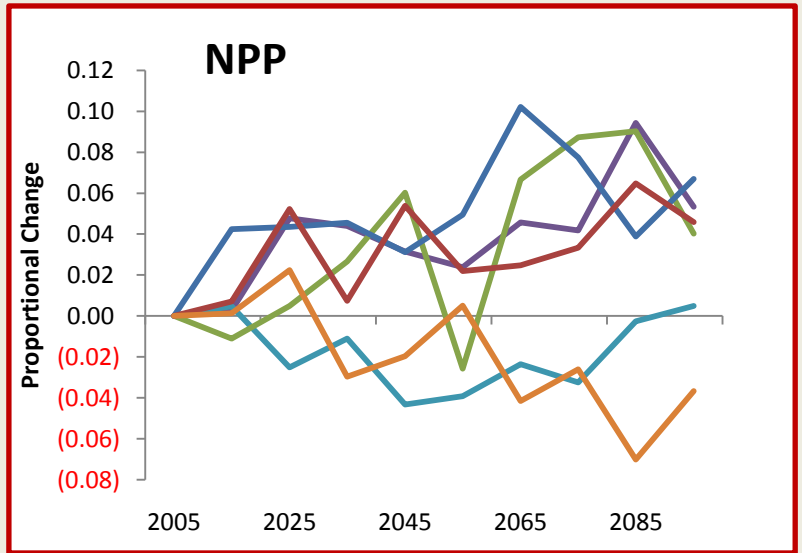
US: Ecosystem models projects a stock increase, but economic model projects a decrease in output…

- Aboveground C declines from the beginning.



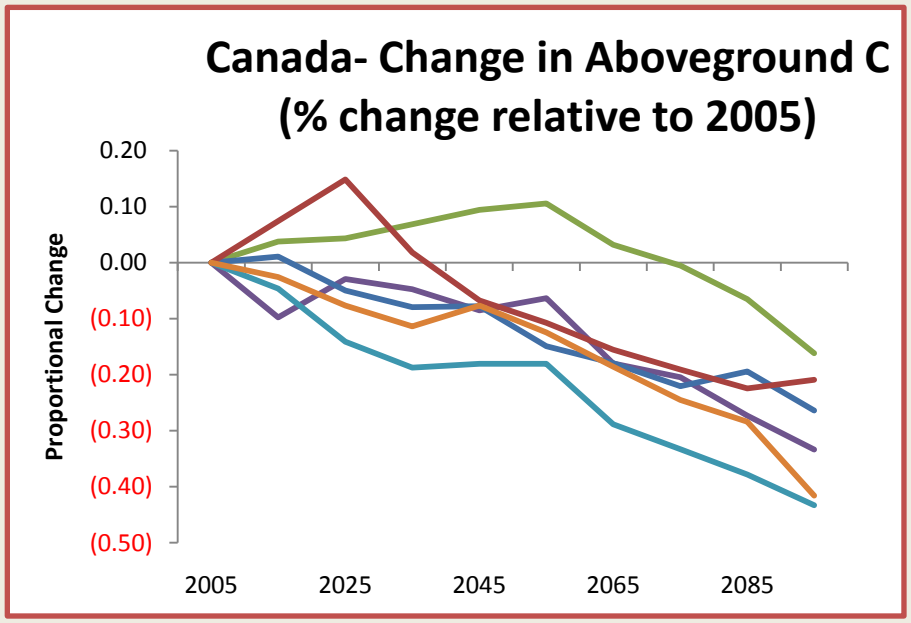
Forest rises a bit over time



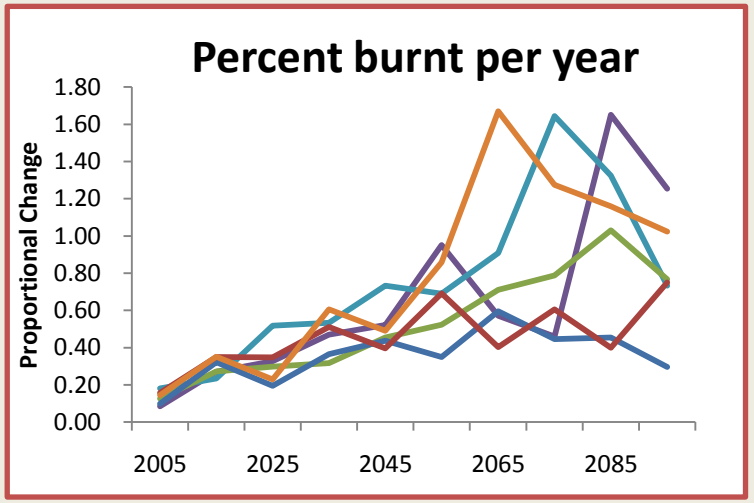


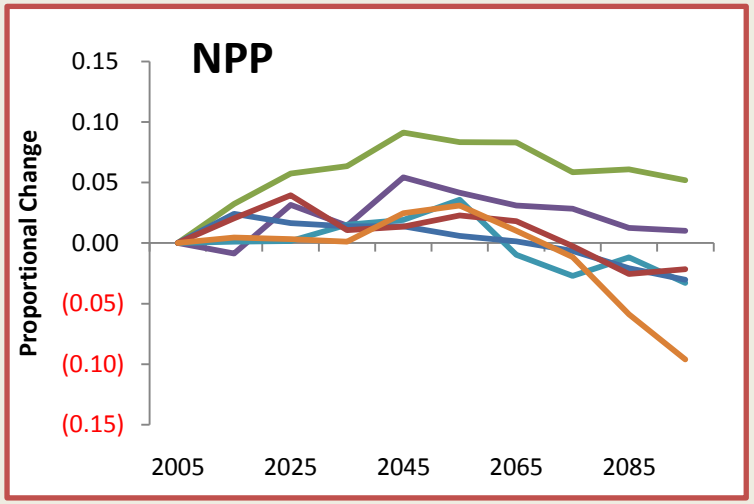
Canada: Ecosystem models project that stocks decline, but output increases

- Aboveground C declines from the beginning.



Forest burning builds over time





Summary and Key Limitations of Analysis

- Newer analysis has different scale of effects (smaller) and different regional implications.
- Economic analysis is evolving relatively slowly.
- Timber markets may not be most important demand on forestland in the future.
- Models are deterministic.
- Ecosystem models are calibrated without human influences.